No. 652,666. Patented June 26, 1900.

P. J. DARLINGTON.

GAGE.

(Application filed Dec. 5, 1898.)

(No Model.)

4 Sheets—Sheet 1.

Fig. 7.

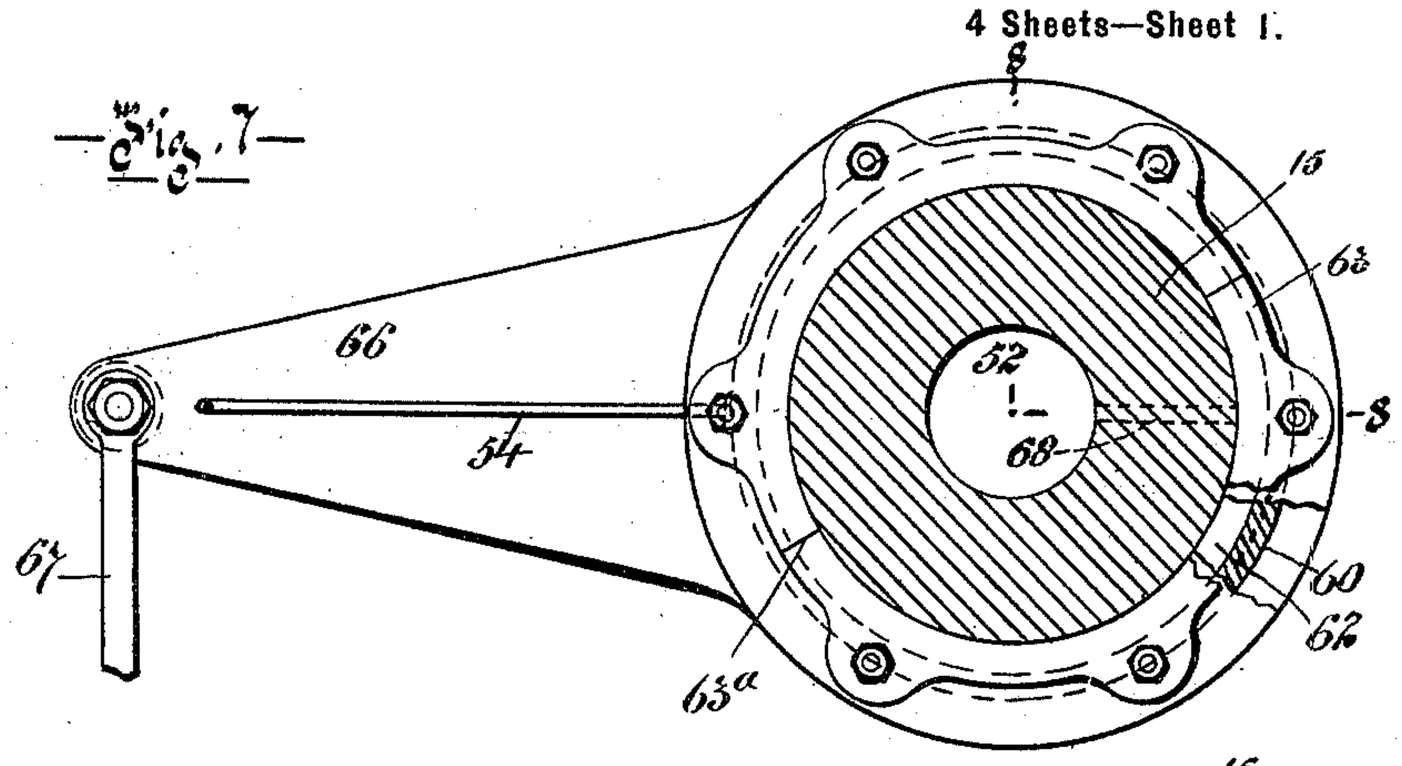


Fig. 8.

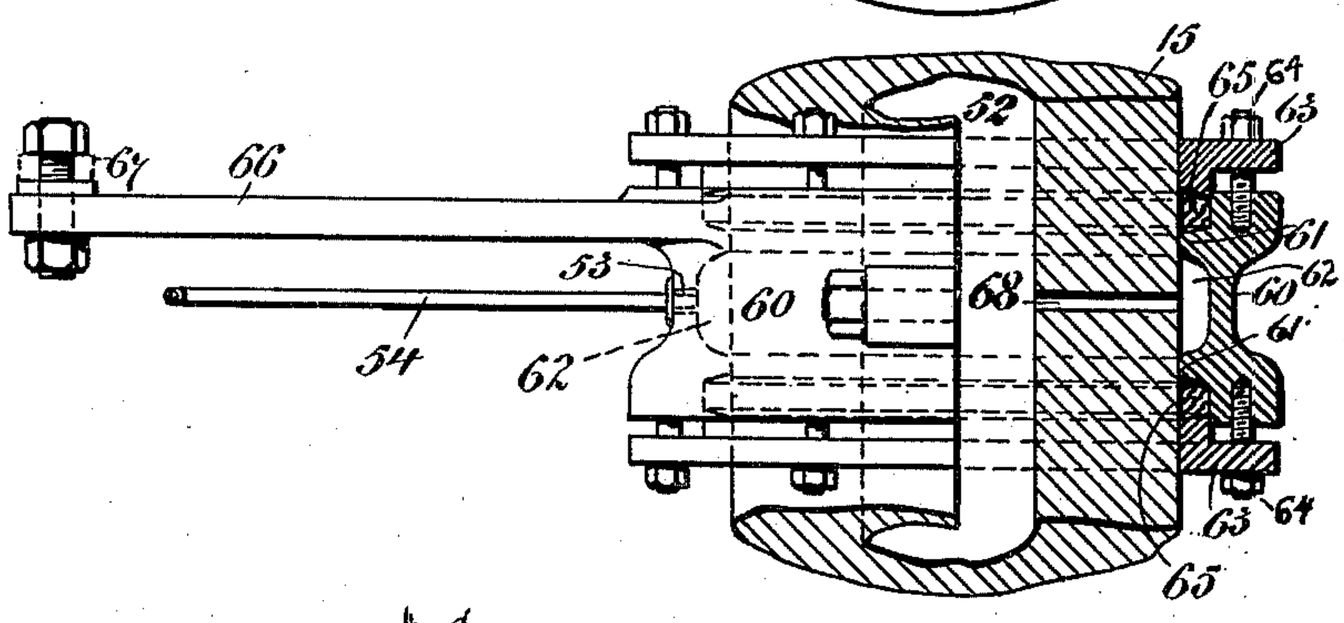


Fig. 1.

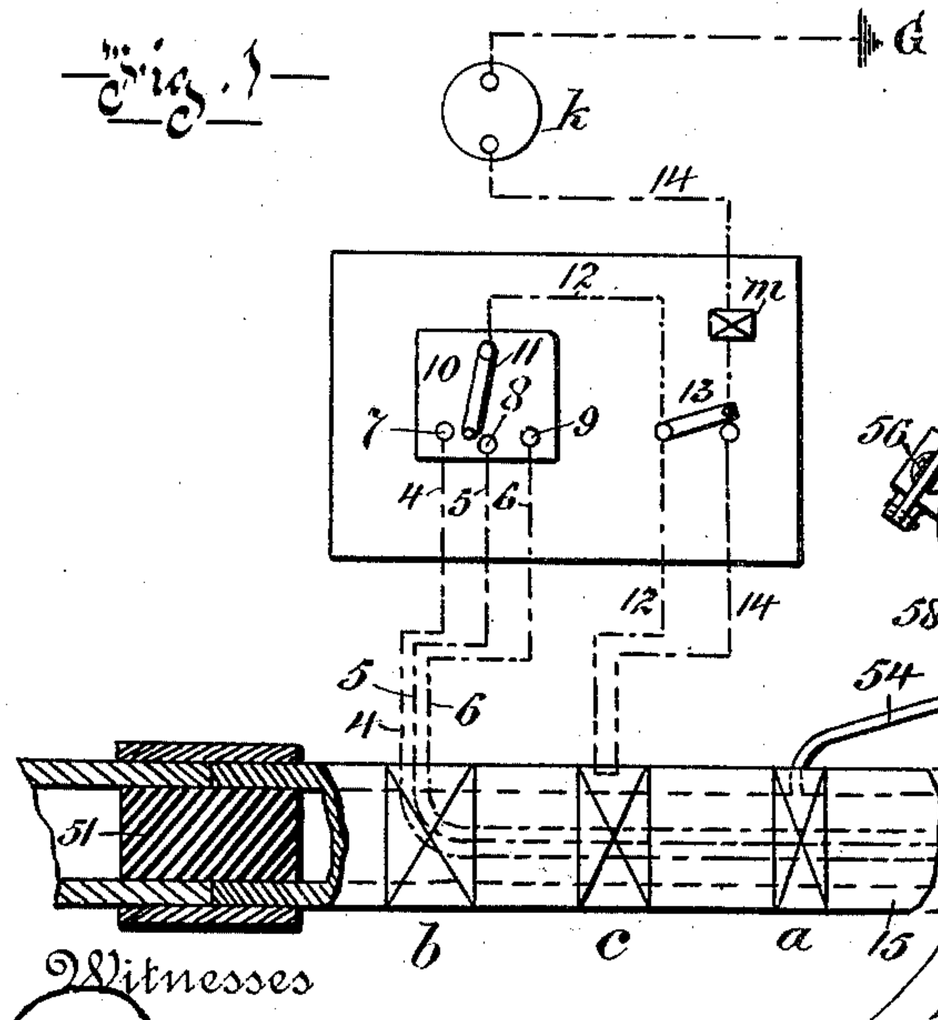
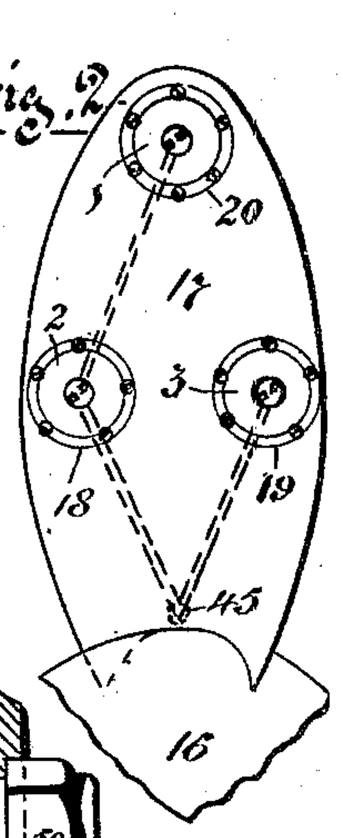


Fig. 2.



Witnesses

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No. 652,666.

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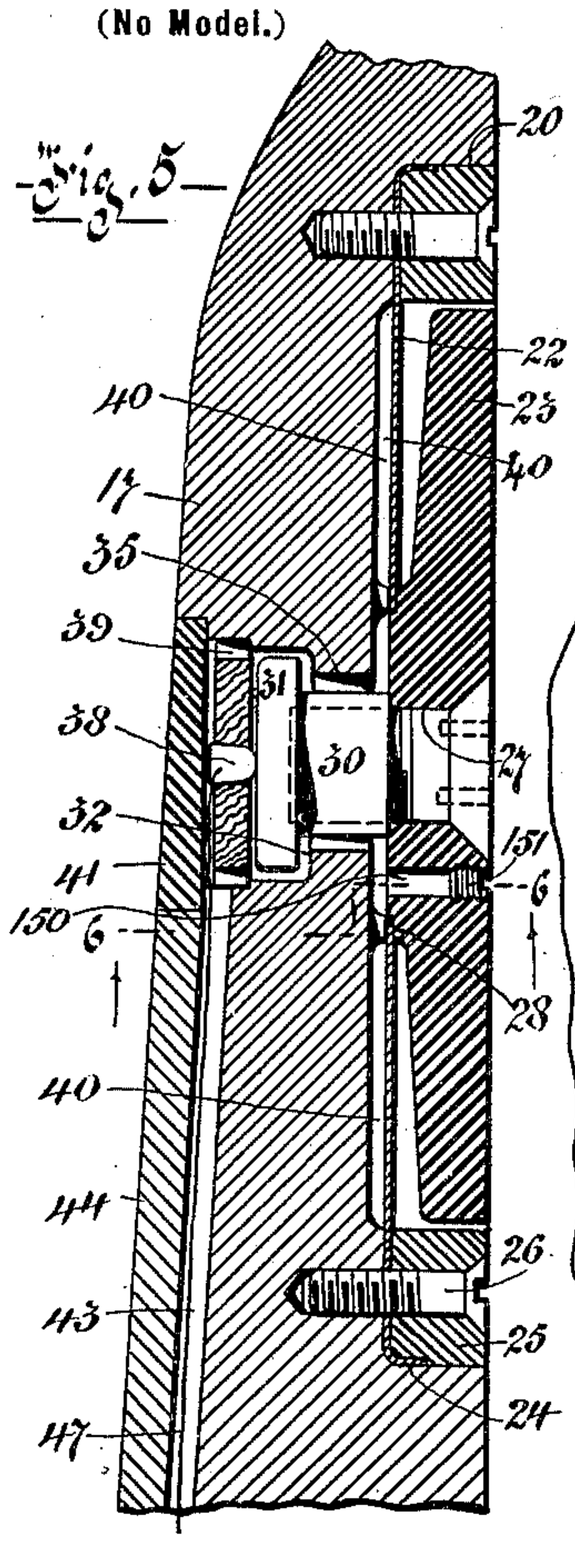
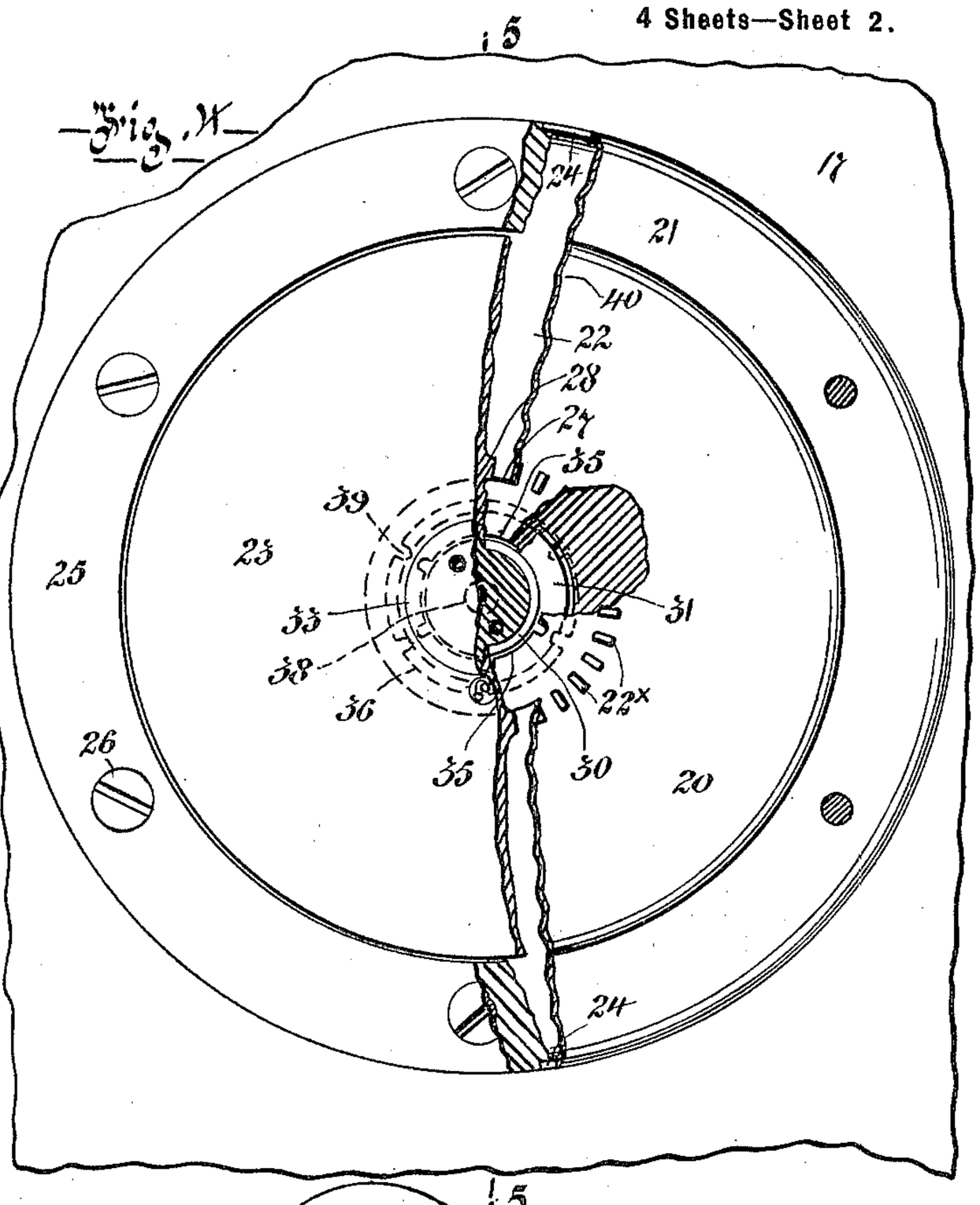
4 Sheets—Sheet 2.

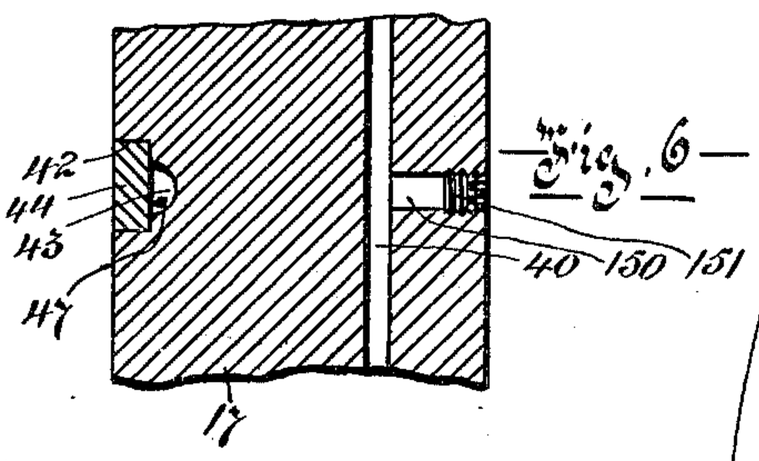
—Fig. 5—



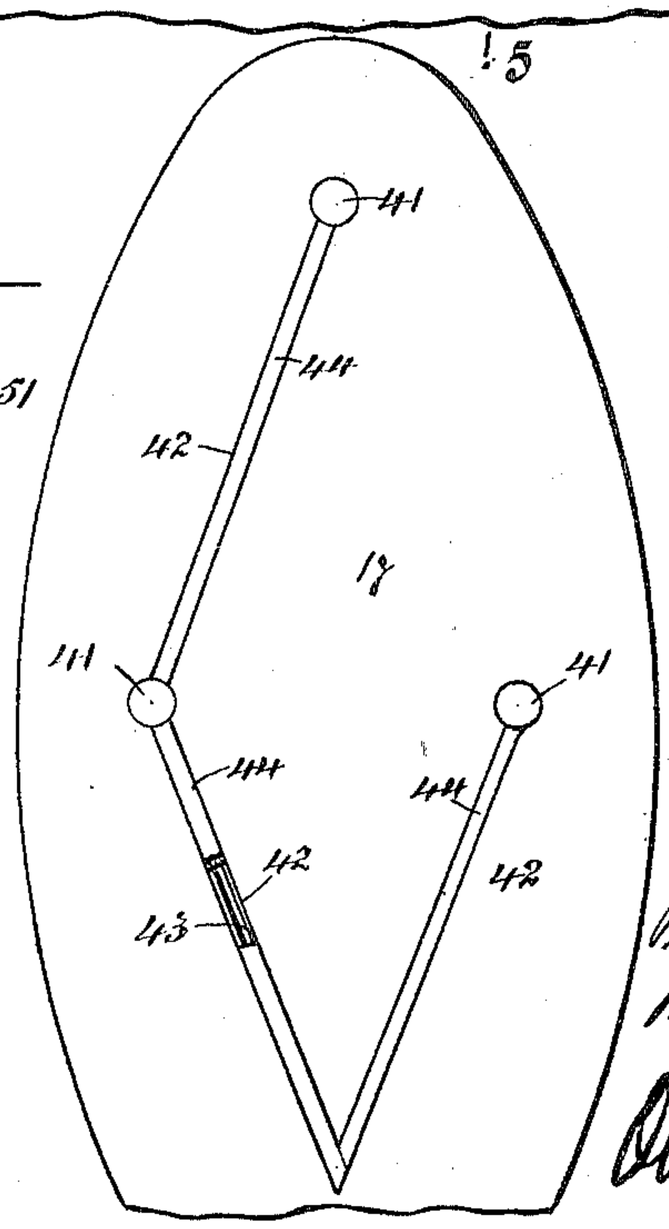
—Fig. 4—



—Fig. 6—



—Fig. 3—



Witnesses

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(Application filed Dec. 5, 1898.)

(No Model.)

4 Sheets—Sheet 3.

Fig. 9

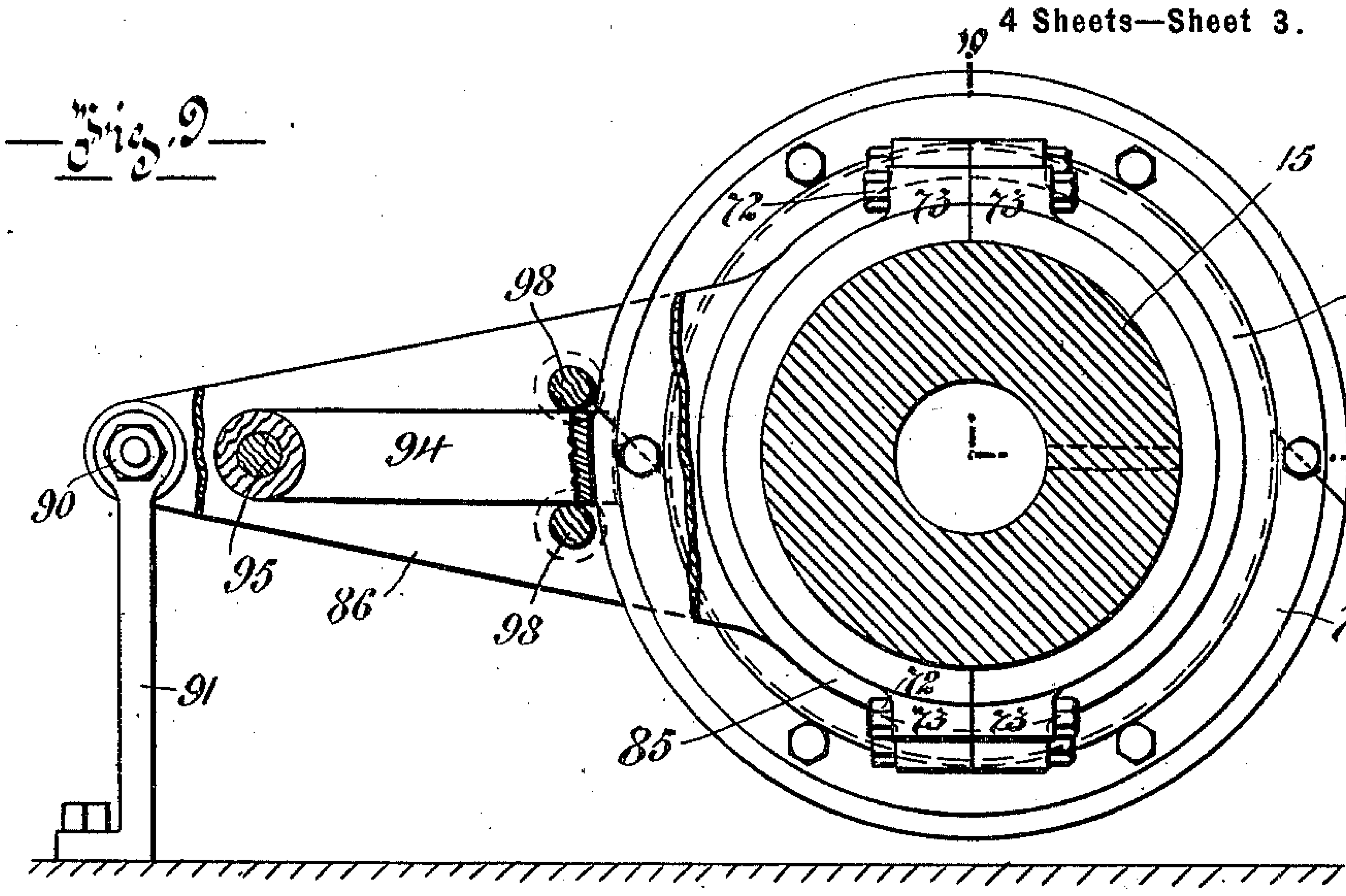


Fig. 10

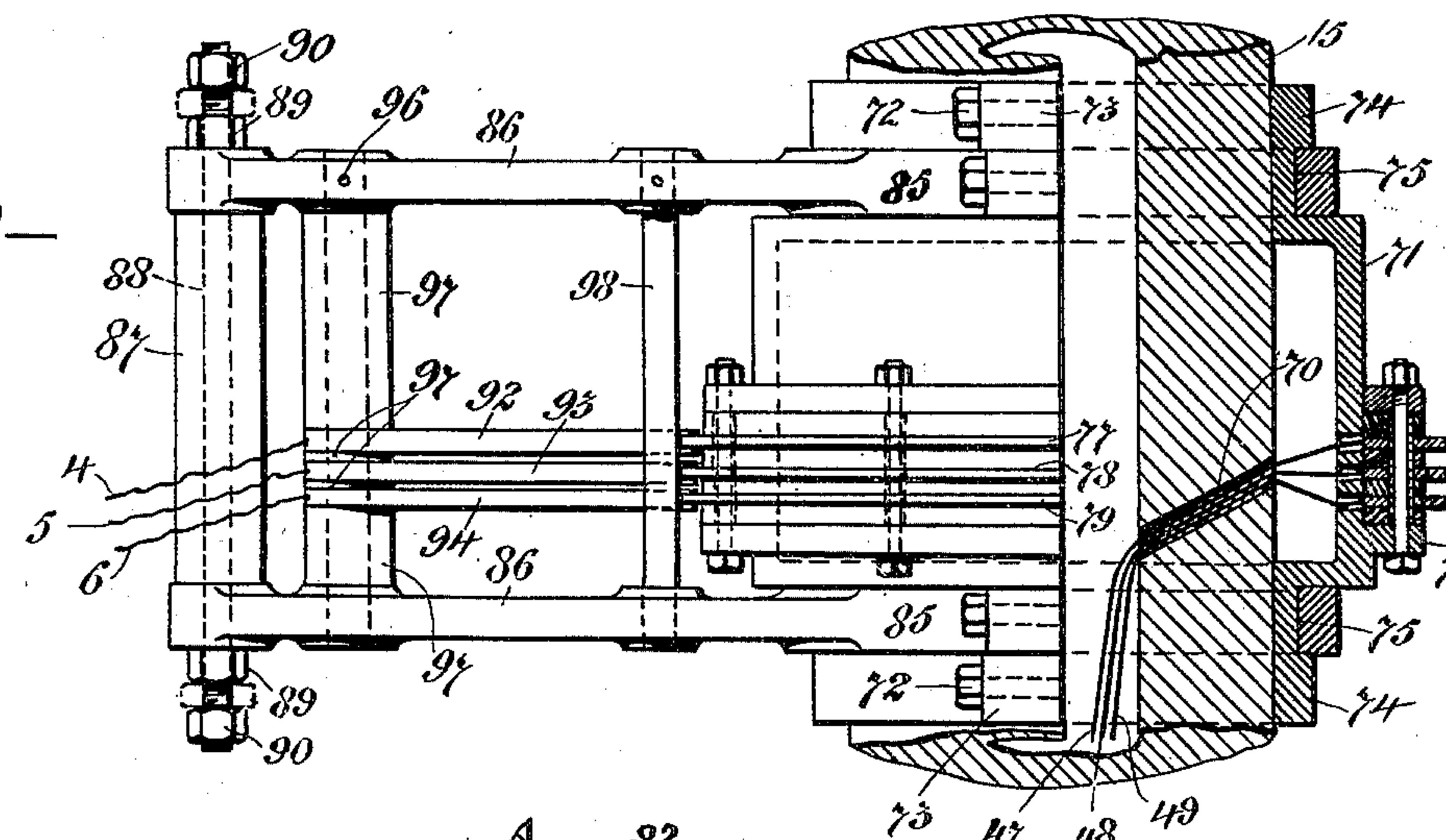
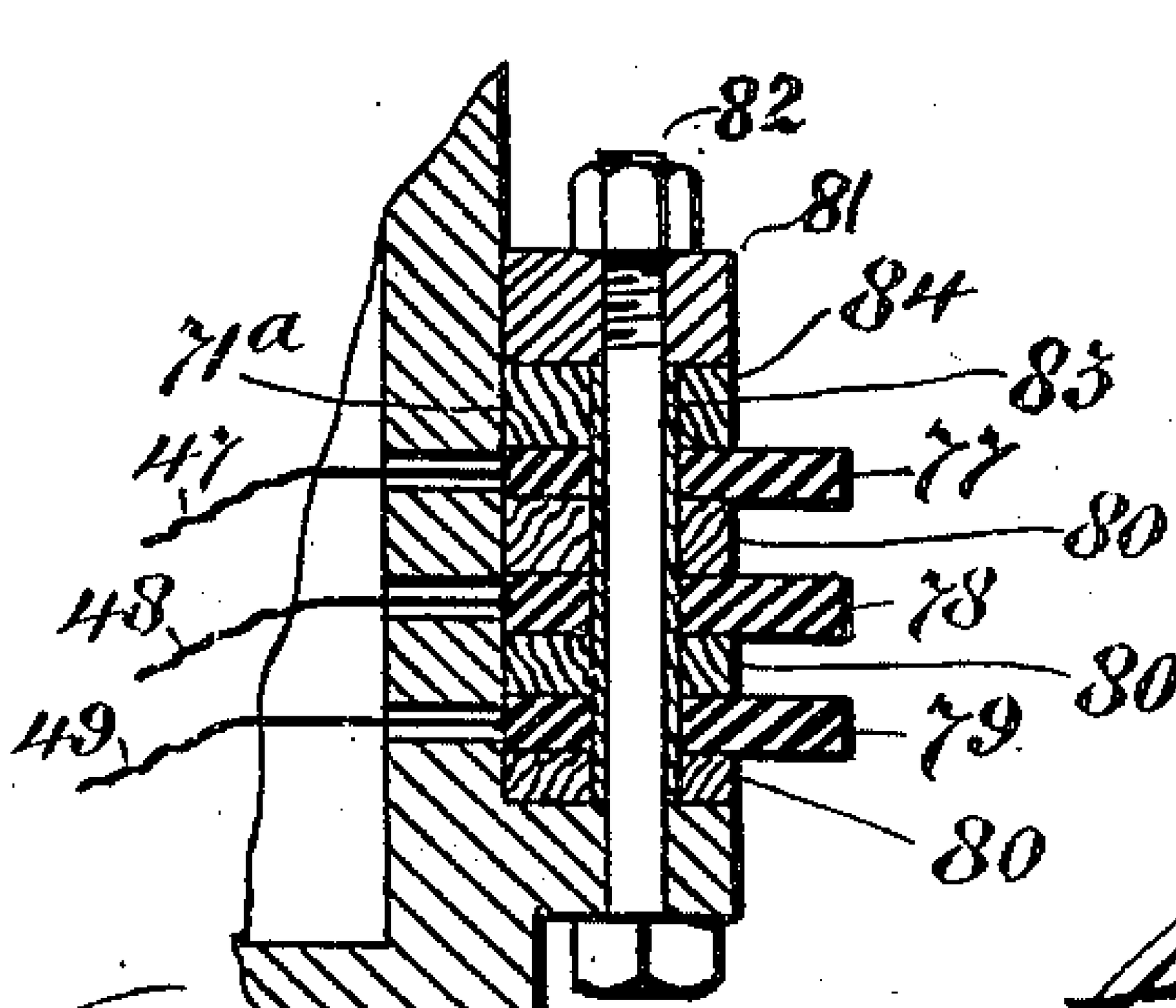


Fig. 11



Witnesses

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No. 652,666.

Patented June 26, 1900.

P. J. DARLINGTON.

GAGE.

(Application filed Dec. 5, 1898.)

(No Model.)

4 Sheets—Sheet 4.

Fig. 12.

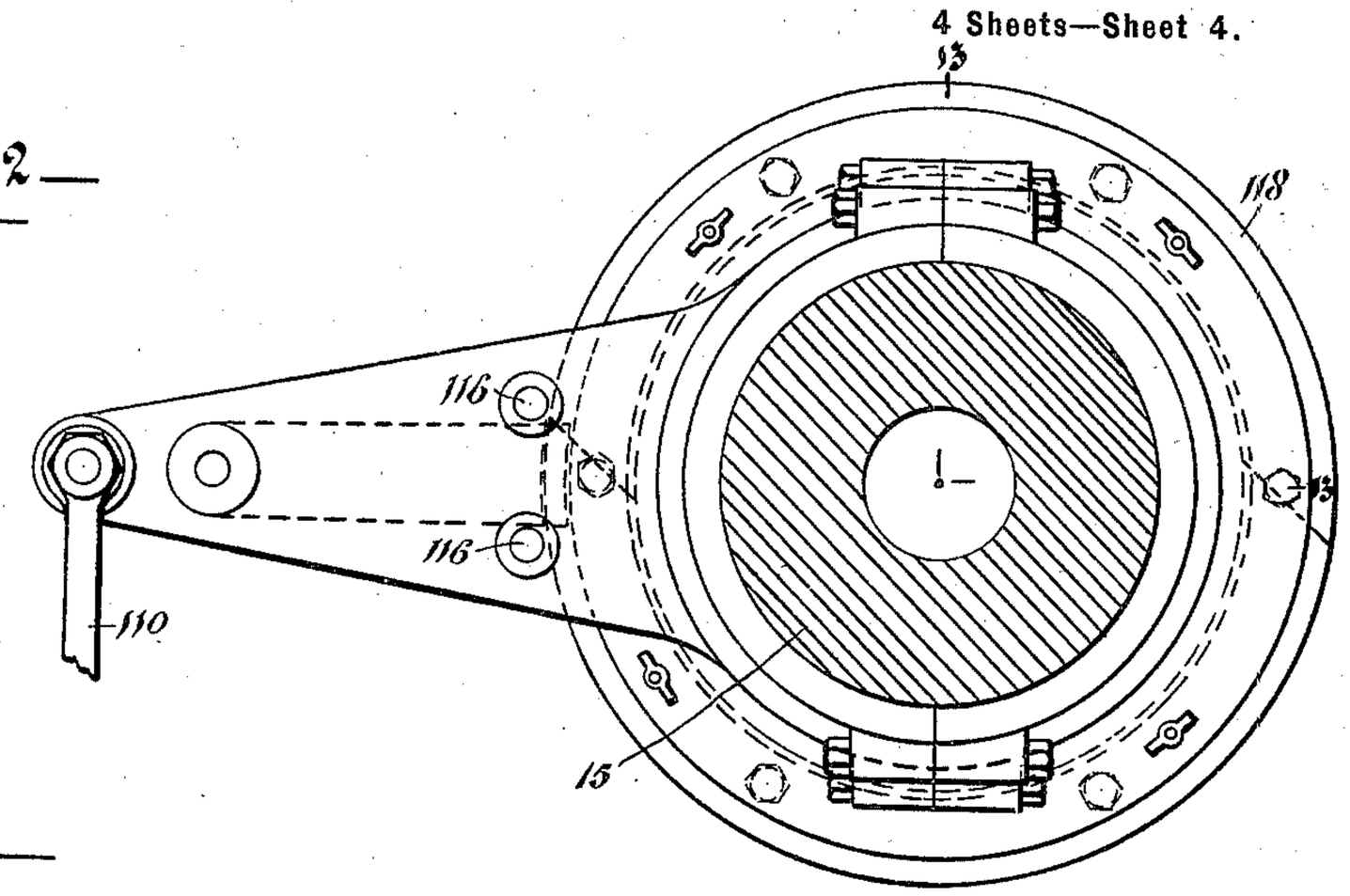


Fig. 13.

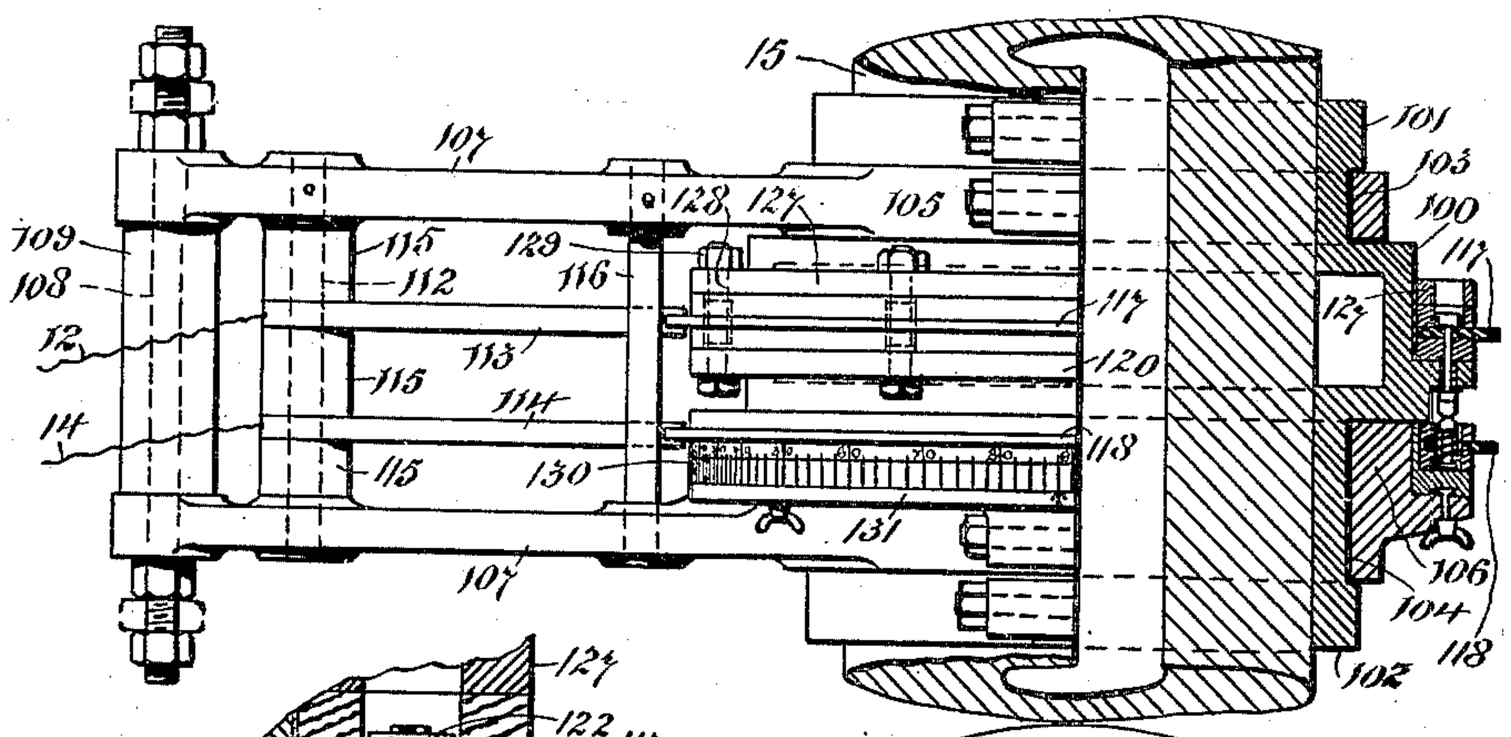


Fig. 14.

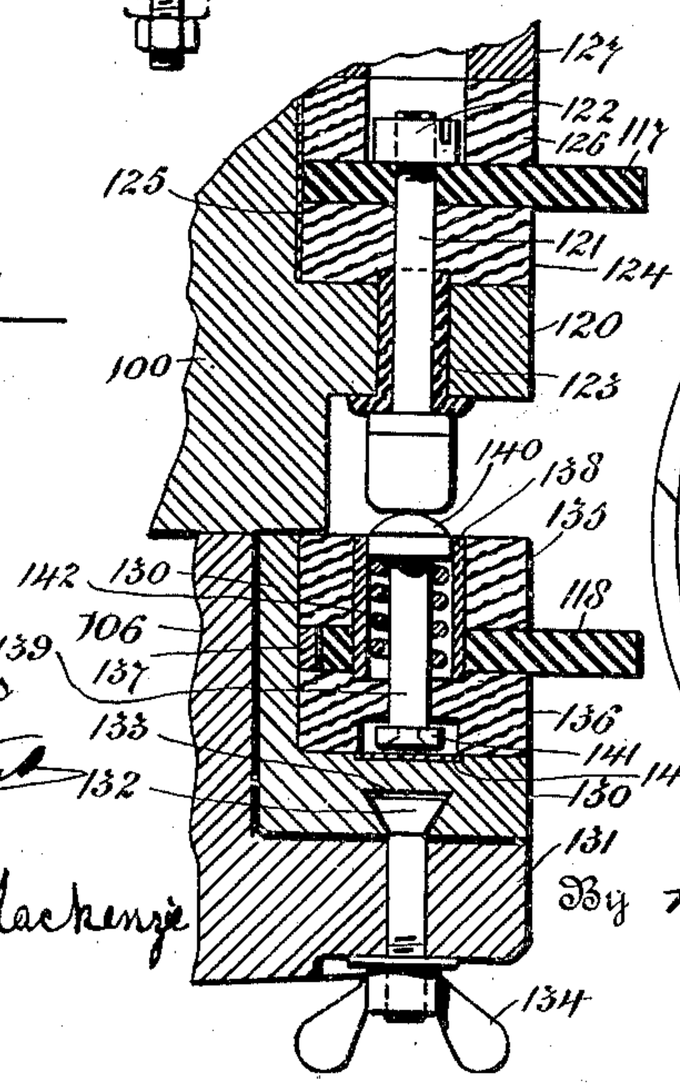
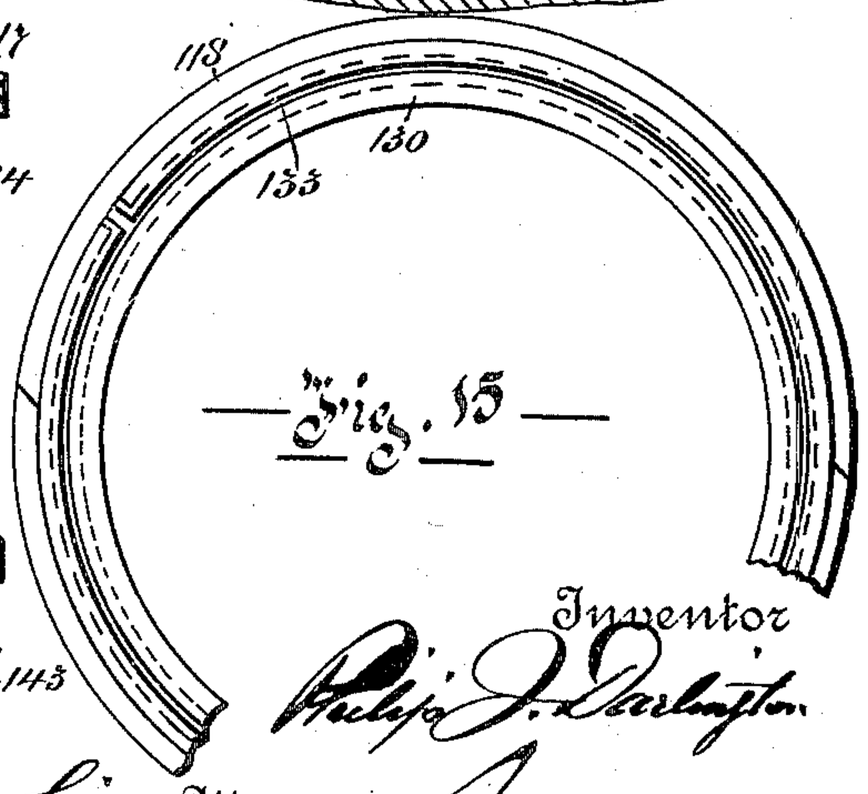


Fig. 15.



Witnesses

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UNITED STATES PATENT OFFICE.

PHILIP J. DARLINGTON, OF MONTREAL, CANADA.

GAGE.

SPECIFICATION forming part of Letters Patent No. 652,666, dated June 26, 1900.

Application filed December 5, 1898. Serial No. 698,354. (No model.)

To all whom it may concern:

Be it known that I, PHILIP J. DARLINGTON, of the city of Montreal, Province of Quebec, Dominion of Canada, have invented certain new and useful Improvements in Gages; and I do hereby declare that the following is a full, clear, and exact description of the same.

My invention has for its object to provide means to ascertain the resistance to or working pressure upon different areas of the surface of any solid in contact with a fluid or of the surface of any intermediary or agent through which motive power is derived by an object, machine, or the like from the resistance offered to said intermediary or agent or the pressure exerted thereupon by a fluid, whether liquid or gaseous.

As an instance where my invention is particularly applicable I may mention what is known as "pounding" in ocean-going vessels. The most popular theory is that this pounding is due to the passing of the propeller-blades through areas of different resistance—as, for instance, when the blades pass from the (comparatively speaking) loose water near the highest point of its revolution relatively to the surface of the water to the more compact mass near the lowest point thereof. The embodiment of my invention hereinafter described in detail and illustrated in the drawings will enable, first, the maximum and minimum degrees of resistance offered to the surface of a propeller-blade during its revolution to be ascertained, and, secondly, to ascertain the precise degree of resistance offered to any one defined area or more different defined areas of the surface of a propeller-blade at any predetermined angular position during its revolution.

The invention may be said broadly to consist in providing the surface of an intermediary or agent such as before mentioned with one or more devices adapted to be held by a known and variable countervailing pressure or force against the fluid in conjunction with which said intermediary or agent may be designed to act to impart motive power to the object, machine, or the like to which said intermediary or agent may be connected, providing means for increasing or diminishing said countervailing pressure or force until it is equal to the resisting force of the fluid, and providing means to indicate at what degree the countervailing pressure or force equalizes the resisting force of the fluid, thereby ascertaining precisely the degree of resisting force of the fluid upon said device or devices carried by the agent.

More specifically speaking, the preferred embodiment of my invention may be said briefly to consist in mounting one or more pressure devices in the form of diaphragms in that face of a propeller-blade the resistance to which it may be desired to ascertain, the outer face of each diaphragm being adapted to be acted upon by the water, while the inner face thereof communicates with an air-tank, means being provided to increase or diminish the pressure of air in said tank and said tank having a pressure-gage to register the pressure therein. An electric circuit is suitably arranged to include a pair of contact-pieces, which are carried one by the diaphragm and the other adjacent thereto by the body of the blade. A second pair of contact-pieces included in a branch of said circuit are carried one by a part moving with the propeller and the other by a part free of said first-mentioned part and adjustable along the line of movement of said moving part in order that said adjustable part may be adjusted to cause the contact-piece carried thereby to register with any predetermined point in the cycle of movement of said moving part and by consequence with a corresponding predetermined angular position of the blade. A switch is included in said main circuit, whereby the branch circuit can be cut out, while a commutating-switch, also included in said main circuit, enables any particular pressure device to be included in the circuit.

For full comprehension, however, of my invention in its entirety reference must be had to the accompanying drawings, forming a part of this specification, in which like symbols indicate the same parts, and wherein—

Figure 1 is a detail diagrammatical view of a propeller and a portion of its shaft with my invention applied thereto. Fig. 2 is a detail elevation of the aft face of a propeller-blade with a series of these pressure devices set therein. Fig. 3 is an elevation of the forward face of said blade. Fig. 4 is an enlarged plan view, partly broken away, of one of the pres-

sure devices. Fig. 5, a transverse vertical sectional view thereof, taken on line 5 5, Fig. 4. Fig. 6 is a horizonal sectional view taken on line 6 6, Fig. 5. Fig. 7 is a detail end elevation of the means for coupling the air-conducting pipe from the tank to the air-passage from the air-chamber of the pressure devices. Fig. 8 is a detail plan view thereof, partly in sectional view, the sectional view being taken on line 8 8, Fig. 7. Fig. 9 is an end view of the collector for receiving the electric current from the wires leading from the contact-points upon the commutating-switch and transmitting it to the wires leading to the pressure devices. Fig. 10 is a plan view thereof, partly in sectional view, the sectional view being taken on line 10 10, Fig. 9. Fig. 11 is an enlarged detail sectional view, taken also on line 10 10, Fig. 9, of the contact-rings and their carrying-rings. Fig. 12 is an end view of the adjustable contact device through which the pressure upon any required defined area of the surface of a blade may be ascertained when the blade is in any predetermined angular position during its rotation. Fig. 13 is a plan view thereof, partly in sectional view, the sectional view being taken on line 13 13, Fig. 12. Fig. 14 is an enlarged detail sectional view taken also on line 13 13, Fig. 12, and illustrating particularly the preferred manner of mounting the contact-pieces carried by said adjustable contact device; and Fig. 15 is a detail end elevation of the adjustable ring for carrying the contact-ring.

The shaft 15 is, as usual, hollow, and the manner of mounting and driving same will of course be according to the work to be done and constitutes no part of my invention.

The propeller consists of a hub 16, having a series of blades 17 rigidly secured thereto. The aft face of the blade has three circular recesses 18, 19, and 20, respectively, cut therein, and the floor of each of these recesses has a shoulder 21 formed at the edge thereof and an outwardly-projecting circular broken ridge $22^{\times}$, of small diameter relatively to each recess, formed concentrically thereof and constituting a seat for a pressure-block. This pressure-block is clearly illustrated in Figs. 4, 5, and 6 and consists of a circular resilient metallic diaphragm 22 and a circular solid metal disk 23. The diaphragm has its edge turned outward, as at 24, to afford a firm hold for a retaining-ring 25, which holds the edge of the diaphragm rigidly upon the shoulder by means of a series of screws 26, taking through said ring and the diaphragm into said shoulder. The diaphragm has a central opening 27, the edges whereof are soldered or otherwise rigidly connected to the recessed edge of a hub-section 28, formed upon the inside face of the disk 23. This circular disk is of a diameter to closely fit within its recess 20, and the outer face thereof conforms to the surface of the blade. A contact-piece is carried by this disk concentrically thereof and consists of a plug 30, having a head 31 formed upon one end thereof, the other end thereof being formed with a screw-threaded boring to receive the end of a screw 33, taking inwardly through a flared screw-threaded central perforation in the disk. The body of this plug takes through a grooved boring 35 in the body of the blade and extending from the center of the recess 20 to the opposite or forward side of the blade, the portion of said boring adjacent to said forward face of the blade being enlarged to accommodate the head of the plug and a small fibrous disk 36 and at the same time afford a shoulder 32 to restrict the extent of displacement of the pressure-block away from its seat, as will be hereinafter clearly set forth. The fibrous disk 36 carries a contact-pin 38, rigidly set therein and having the forward end insulated, and the edge of such disk is formed with a series of grooves 39. The outer end of the enlarged portion of the boring is closed by a disk 41, taking therein and resting upon a shoulder formed by a further enlargement of said outer end.

When three pressure devices are used, they are preferably distributed over the aft surface of the blade, as shown in Fig. 2, and the respective air-chambers 40 behind the diaphragms communicate with one another through chambers formed in the following manner, reference being had particularly to Figs. 2 and 3: A series of rectangular grooves 42, having inward semicircular extensions 43, are cut in the forward face of the blade—*i. e.*, the face opposite to that in which the pressure devices are set—and extend, respectively, one from the chamber of the radially-outermost pressure device indicated at 1, Fig. 2, to the chamber of the pressure device indicated at 2, a second one from the chamber of device 2 to and communicating with the outer end of a diagonally inwardly extending boring 45, while a third groove extends from the pressure device indicated at 3 also to and communicating with the upper end of said boring 45. A rectangular strip 44 is fitted into each of the grooves 42 and secured therein by any suitable packing that will make each of the grooves 43 air-tight. The inner end of this boring communicates with the outer end of a short pipe 46, which extends centripetally through the blade, hub, and shaft, with the interior of which latter the inner end communicates. Before the strips 44 are secured in place electric conductors, consisting of insulated copper wires 47, 48, and 49, are electrically connected at their outer ends to the contact-pins 38 of the respective pressure devices 1, 2, and 3 and taken through the grooves 43, boring 45, and pipe 46 into and along the interior of the shaft, as shown in Figs. 1 and 5. The outer end of the shaft is closed, as usual, by a cap 50, and the interior thereof is divided at the inner end of the first shaft-section by a transverse diaphragm or plug 51, thus providing a main air-chamber 52, communicating through the

pipe 46, boring 45, and air-tight channels 43 with the respective air-tight chambers 40 of the pressure devices. An air-passage 68 is bored through one side of the shaft to communicate with the interior thereof, and the outer end of this passage is coupled to the inner end of an air-conducting pipe 54 by a particular and novel form of coupling *a*, to be presently described. This pipe 54 leads from a tank or reservoir 55, having an air-compressor 56, of any approved construction, connected thereto, and a gage 57, mounted thereon and communicating with the interior thereof, while a valve 58, to be utilized as an air-vent under certain conditions, is located at the juncture of the pipe 54 and said reservoir.

The coupling just mentioned is clearly shown in Figs. 7 and 8 and consists of an annulus 60, divided in an axial plane and secured together and tightened upon the shaft by screw-bolts and having a pair of centrolineally-projecting ridges 61, adapted to closely fit the shaft and form an annular air-chamber 62, encircling said shaft. This air-chamber is made air-tight by a pair of stuffing-boxes constructed of a pair of rings 63 63, divided in an axial plane, as at 63ª, and L shape in cross-section to take into the spaces between the edges of the annulus and the shaft and at the same time extend across the faces of said edges and receive adjusting-screws 64, adapted to take therethrough and into the said edges, while a pair of stuffing-rings 65 are located between the inner edges of these L-rings and the ridges. A radially-projecting arm 66 is formed integrally with said annulus and to one side thereof and is supported at its end from the floor by a leg 67. A passage 68 is bored transversely through the shaft to afford a communication between the interior of said shaft and the annular chamber 62, and a boring 53 radially through the annulus provides a passage, with the outer end whereof the pipe 54 is connected by an air-tight connection. This construction, as is obvious, allows the shaft to rotate without interfering with the communication from the air tank or reservoir to the three chambers of the pressure devices.

The electric conductors 47, 48, and 49 are taken out from the interior of the shaft through a diagonal passage 70, which is sealed, and they are electrically connected, respectively, by an improved electrical collector *b* (to be presently described) to the ends of three conductors 4, 5, and 6, electrically connected, respectively, at their opposite ends to contact points or terminals 7, 8, and 9 upon a commutating-switchboard 10, having a switch-lever 11 fulcrumed thereon. A wire 12 leads from this switch-lever to one of the terminals of a short-circuit switch 13 and thence to one of the terminals of an adjustable contact device *c*, operatively connected to the shaft, as will be also presently described, and a wire 14 leads from the other terminal of this contact device to the other terminal of said switch 13 and thence through a current-indicator *m* to an electric battery *k* and to ground.

My improved collector (see Figs. 9 and 10) consists of a circular box 71, divided in an axial plane and having the parts thereof connected together and clamped rigidly upon the shaft by a pair of screw-bolts 72, taking through adjoining perforated lugs 73, formed upon the abutting edges of a pair of axially-extending flanges 74, formed integrally with the opposite ends of said box and having circumferential depressions or notches 75. A radially-extending circumferential flange 76 is formed on the exterior of the box and has three brass contact-rings 77, 78, and 79 electrically separated from one another and from said flange by fibrous insulation-rings 80, secured thereto by means of a clamping-ring 81 and screw-bolts 82, which latter and the clamping-ring are also respectively electrically separated from the contact-rings by fibrous insulating-bushings and rings 83 and 84, respectively, and the contact-rings are electrically separated from the surface of the box 71 by a sheet of insulating material 71ª. A pair of divided rings 85 encircle the flanges 74, taking into the circumferential depressions 75 therein, and each has a radially-projecting arm 86, formed integrally therewith and connected together at their ends by a localizing-sleeve 87, and a spindle 88, taking through said ends and the sleeve and having its ends screw-threaded to receive jam-nuts 89 and a pair of nuts 90, between which and said jam-nuts the upper perforated ends of a pair of supporting-legs 91 are secured, the lower ends thereof being offset and bolted to the timbers of the vessel. Adjacent to the end of the frame thus formed the outer ends of three brushes 92, 93, and 94 are supported upon a spindle 95, made of wood or other insulating material and held in place with its ends in perforations in the arms 86 of the frame by a pin 96. These brushes are insulated from one another and localized relatively to the respective contact-rings 77, 78, and 79 by fibrous cylindrical sections 97, taking over the spindle 95, while the inner ends thereof are conformed to and bear upon said contact-rings, and their outer ends have the ends of the wires or conductors 4, 5, and 6, respectively, connected thereto. A pair of spindles 98 support said inner ends of the brushes between them and are constructed of wood, fiber, or other insulating material and mounted and held in place with their ends in the arms 86 of the frame similarly to the spindle 95.

The adjustable contact device that I have devised and that I consider as most suitable for the function required of it is constructed and mounted as follows, reference being had to Figs. 11, 12, 13, and 14: A circular box 100, somewhat similar to the box 71, encircles the shaft and is rigidly secured thereon to rotate

therewith similarly to said box 71. Oppositely-extending flanges 101 102 are formed in one with the edges of said box 100 and are provided with circumferential depressions 103 104, respectively, the depression 104 being of greater width than the depression 103. The latter depression 103 receives a ring 105, similar to the rings 81, and the depression 104 receives a ring 106, which closely fits therein, while each of said rings is formed with a radially-projecting arm 107. These arms are connected together and localized relatively to one another by a spindle 108 and sleeve 109, the ends of the spindle, like the spindle 88, being connected to a pair of supporting-legs 110, similar to the legs 91, and a wooden spindle 112 is rigidly mounted at its ends in the arms 107. A pair of contact-brushes 113 114 are supported at their outer ends upon said spindle 112, and are separated by fibrous cylindrical sections 115 from the arms and one another, the inner ends of these brushes being supported between a pair of wooden spindles 116 and conforming to the surface of a pair of contact-rings 117 118, respectively, while the outer ends of these brushes have one end of each of the respective wires 12 and 14 connected thereto. The manner in which these contact-rings are carried is clearly shown in Fig. 13.

The contact-ring 117 is mechanically connected to a radially-projecting circumferential flange 120, formed upon the exterior of the box 100 by a contact-pin 121 passing through said flange and contact-ring and receiving a nut 122. A fibrous bushing 123, a ring 124, and a sheet 125, also of fiber or other insulating material, electrically separates said contact-ring and the contact-pin 121 from the flange and the surface of the box, respectively, while a fibrous insulating-ring 126 is located on the opposite side of the contact-ring. These various parts are clamped rigidly together by a clamping-ring 127 and a series of bolts 128 taking therethrough and through the insulating-rings, contact-ring, and flange, and receiving-nuts 129, the bolts of course being insulated from the contact-ring.

The contact-ring 118 is carried rigidly upon a rotatably-adjustable ring 130, L-shaped in cross-section and mounted upon the ring 106, to which it is adjustably connected by means of a radially-projecting circumferential flange 131, through which project a series of screws having conical heads 132, adapted to take into a dovetail circumferential groove 133, formed in the adjacent face of the ring 130, while the other ends of said screws receive clamping butterfly-nuts 134. A pair of rings 135 136 and a strip 137 of fiber or other insulating material electrically separate the contact-ring 118 from its carrying-ring 130, and a short sleeve 138, of brass or other electroconducting material, is set in the said contact-ring and projects laterally therefrom through one of the insulating-rings toward the contact-ring 117. A contact-pin 139 slides in this sleeve and is formed with a rounded head 140 upon one end and has a collar 141 riveted upon its other end. A coiled spring 142 encircles said pin and bears between said head 140 and the insulating-ring 136, which is recessed to accommodate it and the movement of the collar 141 with the pin, while a disk 143, of insulating material, insulates said collar from the carrying-ring 130, and the periphery of the ring 130 is provided with a graduated rim and the topmost point of the circumferential flange with an index-pointer.

The operation of this embodiment of my invention is as follows: In order to ascertain the maximum or minimum resistance to, say, pressure device 1 during a complete revolution, the commutating switch-lever 11 should be placed upon contact-point 7, thus closing a circuit from battery *k* through wire 14, current-indicator *m*, short-circuit switch 13, (which should be closed,) wire 12, commutating switch-lever 11, contact-point 7, wire 4 to the collector, through brush 92, contact-ring 77, wire 47 to the pressure device, and through the contact-pin 38 and contact-plug 30 to ground in the water. It is obvious that the current will run through this circuit and be indicated by the indicator *m* so long as the resistance to the outside of the diaphragm 22 exceeds the pressure upon the inside thereof, and consequently the pin 38 and plug 30 are in contact with one another. The maximum resistance to the pressure device is ascertained by compressing air by means of the compressor 56 in the tank 55 and through pipe 54, annular air-chamber 62, air-passage 68, air-chamber 52 within the shaft, pipe 46, boring 45, channel 43, grooves 39 of disk 36, and through the grooved boring 35 to the chamber 40, formed by the inner end of the recess 20 and the inside face of the diaphragm, the breaks in the ridge $22^{\times}$ allowing the pressure within this chamber to be distributed evenly throughout the whole surface of the diaphragm. If the air-pressure in this chamber be increased until it equalizes the resistance of the water, then obviously the gage upon the air-tank will indicate through the countervailing force said resistance. I have found it most efficacious to cause the countervailing pressure to exceed the resistance, which will be indicated in the current-indicator by the break of the current at the contact-points 30 and 38, and I then open the air-vent 58 and allow the air to exhaust until there is the least sign, however slight, of current in the indicator. The pressure upon the inside of the diaphragm will then equalize the maximum resisting force upon the outside thereof. To ascertain the minimum resistance upon the pressure device, the countervailing force should be reduced until the current will run freely, except for a short interval, at which interval the indicator will indicate "no current," which obviously will be caused by the countervailing force equalizing the resisting force only at the point of least resistance and

causing a break in the current at the contact-points 30 and 38. The maximum and minimum resistance to either of the pressure devices can be ascertained in this way, and with the maximum and minimum resistance to the defined area of the blade in which each device is located ascertained it is a simple matter to compute the average resistance to the whole blade.

In order to ascertain the resistance to any particular defined area of the blade (by means of the pressure device located within that area) at the instant the blade passes through any predetermined angular plane, and therefore while the blade is instantaneously in that predetermined angular position, the countervailing force should be increased to exceed any possible resisting force, the clamping butterfly-nuts 134 loosened, and the ring 130 adjusted until the degree, upon the graduated rim thereon, corresponding to the angular plane in which it may be desired to obtain a reading, registers with the index-pointer upon the flange 131. Upon the commutating-switch being then placed upon the before-mentioned contact-point, the before-described reading can be had, but of the defined area, containing pressure device 1, when instantaneously in the angular position corresponding to said predetermined angular plane. In obtaining this latter reading the short-circuit switch should be opened, thus causing the current to flow from the battery through the current-indicator, conductor 14 to the adjustable contact device *c*, and through brush 114, contact-ring 118, sleeve 138, pin-head 140, contact-pin 121, contact-ring 117, brush 113, conductor 12, and thence, as before described, through the commutating-switch and pressure device to ground.

Although I have illustrated and described the preferred embodiment of my invention as applicable for ascertaining the resistance to propeller-blades, yet the same embodiment can be applied with substantially the same end in view to the immersed surface of the body of an ocean-going vessel or the like, or to the surface of the vanes of turbine wheels, or, in fact, to any solid that acts upon or is acted upon by a fluid, or to any object, machine, or the like the resistance to or working pressure upon which it may be desired to ascertain, or to the surface of any other intermediary or agent other than a propeller through which motive power is derived by an object, machine, or the like from the resistance offered to said intermediary or agent or the pressure exerted thereupon by a fluid, whether liquid or gaseous, without departing from the spirit of my invention.

It is obvious that moisture due to the sweating of the blade is liable to collect in the channels 43, and if subjected to a temperature below freezing-point will freeze and prevent the variation in the pressure of the air being recorded from the pressure device to the pressure-gage upon the tank. I obviate this defect by providing a passage 150 in each pressure device and extending from the aft face thereof through the disk 23 to the nearest point in the air-chamber, this passage being screw-threaded at its outer end to receive a screw-threaded plug 151, by the removal of which all moisture can be blown out of the chamber through said passages 150. The passages also enable the directions of currents from the propeller-blade to be ascertained by removing the plug and forcing a colored fluid by means of the compressor through the pipes, coupler, shaft, channels, and said passage 150 into the water, wherein the currents will be indicated by said colored liquid, which will naturally flow therewith.

What I claim is as follows:

1. In combination with an immersed part of a marine vessel, a gage for ascertaining the resistance to or pressure upon the surface of said immersed part when said vessel is in motion comprising one or more pressure devices carried by the exposed surface of said immersed part, and with the outer face or faces thereof in contact with the water; means for causing a countervailing force to act upon the inner face or faces of said pressure device or devices; means for varying said countervailing forces; electrical means for indicating when said countervailing force equals the force of said resistance to or pressure upon the surface of said immersed part; and means for indicating the degree of said countervailing force.

2. In combination with a solid medium through which power is transmitted, a gage for ascertaining the resistance to or pressure upon the surface of said solid medium comprising one or more pressure devices carried by said medium; means for causing a countervailing force to act upon the face or faces of said pressure device or devices opposite to the face or faces upon which said pressure is exerted or to which said resistance is offered; means for varying said countervailing force; electrical means for indicating when said countervailing force equals the force of said resistance to or pressure upon the surface of said immersed part; and means for indicating the degree of said countervailing force.

3. In combination with an immersed part of a marine vessel, a gage for ascertaining the resistance to or pressure upon said immersed part and consisting of one or more pressure devices carried by the immersed part and having the outer face or faces thereof in contact with the water in which said part is immersed; an air-tank; an air-compressor connected to said tank; a pressure-gage carried by said tank; an air-chamber located adjacent to and inclosing the rear face of each of said pressure devices; one or more air-conductors leading from said tank to said chamber or chambers; and electrical means for indicating when the pressure in said chamber or chambers equalizes the resistance of the water.

4. A gage for ascertaining the resistance to, or working pressure upon, any intermediary or agent through which motive power is derived by an object, machine, or the like, from the resistance offered to said intermediary or agent, or the pressure exerted thereupon by a fluid, whether liquid or gaseous, said gage consisting of one or more pressure devices carried by the surface of said intermediary or agent and having the outer face or faces thereof in contact with said fluid; an air-tank; an air-compressor connected to said tank; a pressure-gage carried by said tank; an air-chamber located adjacent to and inclosing the rear face of each of said pressure devices; one or more air-conductors leading from said tank to said chamber or chambers; an electric circuit comprising a battery, a contact-piece carried by each pressure device and a contact-piece carried adjacent to said first-mentioned contacts, by the body of the intermediary or agent, for indicating when the pressure in said chamber or chambers equalizes the resistance of the fluid.

5. A gage for ascertaining the resistance to, or working pressure upon, any intermediary or agent through which motive power is derived by an object, machine, or the like, from the resistance offered to said intermediary or agent, or the pressure exerted thereupon by a fluid, whether liquid or gaseous, said gage consisting of one or more pressure devices carried by the surface of said intermediary or agent and having the outer face or faces thereof in contact with said fluid; an air-tank; an air-compressor connected to said tank; a pressure-gage carried by said tank; an air-chamber located adjacent to and inclosing the rear face of each of said pressure devices; one or more air-conductors leading from said tank to said chamber or chambers; means for indicating when the pressure in said chamber or chambers equalizes the resistance of the fluid; and means for causing said indication to be given at any predetermined degree of the cycle of movement of said intermediary or agent.

6. A gage for ascertaining the resistance to, or working pressure upon, any intermediary or agent through which motive power is derived by an object, machine, or the like, from the resistance offered to said intermediary or agent, or the pressure exerted thereupon by a fluid, whether liquid or gaseous, said gage consisting of one or more pressure devices carried by the surface of said intermediary or agent and having the outer face or faces thereof in contact with said fluid; an air-tank; an air-compressor connected to said tank; a pressure-gage carried by said tank; an air-chamber located adjacent to and inclosing the rear face of each of said pressure devices; one or more air-conductors leading from said tank to said chamber or chambers; an electric circuit comprising a battery, a contact-piece carried by each pressure device and a contact-piece carried adjacent to said first-mentioned contacts by the body of the intermediary or agent, and for indicating when the pressure in said chamber or chambers equalizes the resistance of the fluid; and means for causing said indication to be given at any predetermined degree of the cycle of movement of said intermediary or agent.

7. In combination with a hollow shaft and a blade of a propeller mounted thereon, a series of pressure devices carried by said blade and each consisting of a disk mounted in a recess in the surface of said blade, the inner end of said recess constituting an air-chamber closed at its outer end by said disk; an air-channel leading from each of said chambers to the interior of the shaft, an air-tank; an air-tube leading from said tank; means for coupling said air-pipe to a perforation in the shaft leading from the interior thereof; an air-compressor connected to said tank; a pressure-gage mounted upon said air-tank; a contact-piece movable with said disk and projecting through the inside thereof; a contact-piece carried by the body of the blade adjacent to said first-mentioned contact-piece; means for insulating said last-mentioned contact-piece from the body of the blade; a series of contact-rings encircling the shaft; means for connecting said rings rigidly to the shaft; a series of insulated conductors electrically connecting said rings respectively to the last-mentioned contact-pieces of the pressure device, a stationary frame; a series of electrical brushes carried by said frame and each bearing upon one of the said contact-rings; a commutating-switch; a series of conductors electrically connecting said contact-rings to said commutating-switch; a current-indicator; a conductor electrically connecting said current-indicator to the lever of said commutating-switch; and an electric battery with ground connection electrically connected to said indicator, substantially as described and for the purpose set forth.

8. In combination with a hollow shaft and a blade of a propeller mounted thereon, a series of pressure devices carried by said blade and each consisting of a resilient diaphragm mounted in a recess in the surface of said blade, the inner end of said recess constituting an air-chamber closed at its outer end by said diaphragm; air-channels leading from each of said chambers to the interior of the shaft; an air-tank; an air-pipe leading from said tank; means for coupling said air-pipe to a perforation in the shaft leading from the interior thereof; an air-compressor connected to said tank; a pressure-gage mounted upon said air-tank; a contact-piece movable with each of said diaphragms, and projecting through the inside thereof; a contact-piece carried by the body of the blade adjacent to each of said first-mentioned contact-pieces; means for insulating said last-mentioned contact-pieces from the body of the blade; a commutating-switch; a short-circuit switch; a current-indicator; an electric battery; col-

lecting means for electrically connecting the contact-points of said commutating-switch to the contact-pieces carried by the body of the blade; a main electric circuit including said battery, current-indicator, switch, collecting means, and contact-pieces; adjustable contact means comprising a contact-piece rotatable with the shaft; a part adjustable around said shaft and a contact-piece carried by said adjustable part and located in the line of movement of the contact-piece rotatable with the shaft; a branch circuit from one to the other of the terminals of said short-circuit switch and including said adjustable contact means, substantially as and for the purpose set forth.

9. In combination with a propeller-blade of a marine vessel, a gage substantially as described for ascertaining the resistance to said propeller-blade, a hollow shaft for rotating said propeller and having an air-chamber in the interior thereof, said air-chamber communicating with the exterior by a boring; an air-compressor; an air-conducting pipe leading from said compressor toward said boring; a device for coupling said pipe to said air-chamber, comprising a stationary annulus having a pair of centrolineally-extending flanges fitting the exterior of said shaft one on each side of said boring; a pair of stuffing-boxes hermetically sealing the spaces between the edges of said annulus and the shaft; means for retaining said annulus against rotation; said pipe being connected to the chamber formed by said annulus, substantially as described and for the purpose set forth.

10. In combination with a propeller-blade of a marine vessel, a series of electrical contacts yieldingly carried by the propeller-blade, each contact having one of its faces exposed; a second series of electrical contacts carried by said propeller-blade in close proximity to but normally out of contact with the inner or unexposed faces of said first series of contacts, a hollow shaft for rotating said propeller and having a radial boring therethrough; a circular box encircling said shaft; means for rigidly connecting said box to said shaft; a series of contact-rings, encircling said box and rigidly carried thereby and insulated therefrom; a series of electrical conductors located within said shaft and extending through said boring and each being electrically connected at one end to one of the rings of said series and at its other end to one of said second contacts; a part mounted stationary within the vessel; a series of brushes carried by said stationary part and bearing upon said contact-rings; an electric generator; a switchboard comprising a switch and a series of terminals; a current-indicator; a conductor connecting said generator to the current-indicator and the current-indicator to the switch of said switchboard; a series of conductors connecting the terminals of said switchboard to said series of brushes; substantially as described and for the purpose set forth.

11. In a gage substantially as described for ascertaining the resistance to propeller-blades, at any predetermined angular position during their revolution, the combination of an electric circuit, substantially as described and including a short-circuit switch; a circular box encircling said shaft; means for rigidly connecting said box to said shaft; a contact-ring encircling said box and rigidly carried thereby and insulated therefrom; a contact-piece carried by said box and insulated therefrom and in electrical contact with said contact-ring; a frame having an annular extension adapted to encircle said box adjacent to said contact-ring; means for retaining said frame against rotation with the shaft; an adjustable carrying-ring rotatably mounted upon and encircling said annular extension; means for connecting and disconnecting said ring and annular extension; a contact-ring encircling said carrying-ring and rigidly carried thereby and insulated therefrom; a yielding contact-piece carried by said carrying-ring, and insulated therefrom and in electrical contact with said last-mentioned contact-ring; a pair of brushes insulated from one another and carried by and insulated from said stationary frame, said brushes bearing respectively upon said contact-rings; and a branch circuit from terminal to terminal of said short-circuit switch and including said contact-rings, substantially as described and for the purpose set forth.

12. In a vessel, the combination of a shaft having a longitudinal passage, a propeller mounted on said shaft, one of the blades of said propeller being provided with one or more passages each communicating at one end with the passage in the shaft and at its other end with an opening extending to the surface of said blade, and means for forcing a fluid through said passages, for the purpose set forth.

13. In combination with a hollow propeller-shaft, and a propeller mounted thereon, one of the blades whereof is provided with one or more passages each leading from the aft toward the forward face thereof; said passage or passages each having a removable plug in the end or ends thereof; one or more channels leading from said passage or passages to the interior of the shaft, said shaft having an additional passage from the interior to the exterior thereof; a compressor, a pipe leading from said compressor to the last-mentioned passage, and means for coupling said passage and pipe together, whereby the shaft will be free to rotate while the pipe will remain stationary, for the purpose set forth.

In testimony whereof I have affixed my signature in presence of two witnesses.

PHILIP J. DARLINGTON.

Witnesses:

WILLIAM P. MCFEAT,

FRED. J. SEARS.